Please state clearly all assumptions made in order for full credit to be given.

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**Problem #1 (25 %)**

Consider the following matrix:

\[
A = \begin{bmatrix}
6 & 0 & 2 & -3 & 4 \\
0 & 0 & 2 & 1 & 2 \\
5 & 6 & -4 & -3 & 3 \\
0 & 0 & 3 & -3 & 1 \\
0 & 0 & -2 & 3 & -3
\end{bmatrix}
\]

a) Use the method of cofactor expansion to find det( \( A \))  

b) Use the method of matrix inversion to invert the bold-face 3x3 matrix

**Note:** No credit will be given to any numerical result unless **ALL** intermediate work is shown.
Problem #2 (25%)

The assembly composed of a rigid rod $CD$ and a bent $ACEF$ is used to support a cylinder ($W = 250$ lb). The support at $A$ is a ball-and-socket joint. The support at $E$ is a journal bearing. The journal bearing has been properly aligned so that it exerts only force reactions on member $ACEF$. At equilibrium, the rod connected to the bent at $C$ is vertical.

1. Draw FBD of $ACEF$ (i.e., excluding the rod $CD$ in the assembly) (4)
2. Express all forces, known and unknown, in Cartesian vector form (4)
3. Write the equilibrium equations for the bent $ACEF$ (3)
4. Determine the components of reaction at $A$, $E$, and the force developed along rod $CD$ (14)
Problem #3 (25 %)

1. For the truss shown determine:
   a. the reaction forces at C and E  
   b. by using the method of joints, the force in ALL the members of the truss shown and state whether the member is in tension or compression.

(To receive credit draw all the Free Body Diagrams FBDs required for solving the problem)
**Problem #4 (25%)**

The frame shown below consists of a bracket ABC and 2 bars CD and DE. The frame is supported by two frictionless pins at A and E. The connections at C and D are also made of frictionless pins. A force of 1000 N is applied to the bracket ABC and a force P is applied at joint D.

a) Determine all the forces acting on the bracket ABC  

b) Determine the force P needed to maintain the bracket ABC in the position shown

Draw all free body diagrams needed to support your work separately from the frame shown below.

All dimensions are in mm
1. Ball and socket
A ball-and-socket joint (see Fig. 6-14) can transmit a force $R$ but no moment. The force $R$ is usually represented on a free-body diagram by its three rectangular components $R_x$, $R_y$, and $R_z$.

2. Hinge
A hinge (see Fig. 6-15) is normally designed to transmit a force $R$ in a direction perpendicular to the axis of the hinge pin. The design may also permit a force component to be transmitted along the axis of the pin. Individual hinges have the ability to transmit small moments about axes perpendicular to the axis of the pin. However, properly aligned pairs of hinges transmit only forces under normal conditions of use. Thus, the action of a hinge is represented on a free-body diagram by the force components $R_x$, $R_y$, and $R_z$ and the moments $M_x$ and $M_y$ when the axis of the pin is in the $y$-direction.

3. Ball bearing
Ideal (smooth) ball bearings (see Fig. 6-16) are designed to transmit a force $R$ in a direction perpendicular to the axis of the bearing. The action of the bearing is represented on a free-body diagram by the force components $R_x$ and $R_y$ when the axis of the bearing is in the $y$-direction.

4. Journal bearing
Journal bearings (see Fig. 6-17) are designed to transmit a force $R$ in a direction perpendicular to the axis of the bearing. Individual journal bearings (also known as bushings) have the ability to transmit small moments about axes perpendicular to the axis of the shaft. However, properly aligned pairs of bearings transmit only forces perpendicular to the axis of the shaft under normal conditions of use. Therefore, the action of a journal bearing is represented on a free-body diagram by the force components $R_x$ and $R_y$ and the couple moments $M_x$ and $M_y$ when the axis of the bearing is in the $y$-direction.